

The role of nanocomposite electrolytes in the development of reliable and efficient lithium polymer batteries.

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We have demonstrated in the past that the addition of selected ceramic particles to poly(ethylene oxide), PEO-based membranes leads to the formation of nanocomposite polymer electrolytes having improved electrochemical and physical properties.¹⁻³. Among these figure the stabilization of the Li metal interface, the enhancement of the overall ionic conductivity and, particularly, of the lithium ion transference number. These features increase the interest of the nanocomposite polymer electrolytes as preferred separators for reliable and versatile lithium polymer batteries. Indeed, the stabilization of Li interface is expected to favor long cyclability and the enhancement in conductivity and in Li transference number are expected to allow wide temperature operation ranges and high power capabilities, respectively.

In this work we confirm the practical relevance of the nanocomposite electrolytes by demonstrating their influence in assuring high performance to related rechargeable lithium polymer batteries. Examples are batteries formed by combining the lithium metal anode with suitable cathodes, such as LiMn_2O_4 and LiFePO_4 .^{5,6} Figure 1 shows the cycling response of a Li /PEO-nanocomposite/ LiMn_2O_4 cell at 70 °C.⁷. The result show that the cell cycles quite satisfactorily at a high rate at a temperature value where common Li polymer batteries have difficulties to operate (PEO crystallizes around 70°C), this clearly being associated to the enhanced conductivity of the nanocomposite electrolyte.

Figure 2 shows the polarization curve at 105 °C of a second type of the cells tested in our laboratory, i.e. the Li/PEO-nanocomposite/ LiFePO_4 cell.⁸. To be noticed that this cell can sustain current rates up to about 2C before reaching concentration polarization limits. The current levels associated to these rates are far beyond the limiting values reported for conventional Li polymer batteries, this being associated to the enhanced lithium transference number of the nanocomposite electrolyte.

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References.

1) F. Croce, G. B. Appetecchi, L. Persi, B. Scrosati, *Nature*, **394**, 456 (1998).
2) M.C. Borghini, M. Mastragostino, S. Passerini and B. Scrosati, *J. Electrochem. Soc.* **142**, 2118 (1995)
3) F. Croce, R. Curini, A. Martinelli, L. Persi, F. Ronci, B. Scrosati, *J. Phys. Chem. B.*, **103**, 10632 (1999).
4) M.Yoshio, H.Nakamura, Y.Xia, *Electrochim. Acta*, **45**,273 (1999).
5) A.K.Padhi, K.S.Nanjundaswamy and J.B.Goodenough, *J.Electrochem.Soc.*, **144** , 1188 (1997).
5) N.Ravet, J.B.Goodenough, S.Besner, M.Simoneau, P.Hovignon and M.Armand, 196th ECS Meeting,Hawaii, October 17-22, Abstr. 127, (1999).

6) L.Persi, B.Scrosati, M.A.Hendrickson, E. Plichta, submitted
7) F. Croce, F.Serraiono-Fiory, L. Persi, B. Scrosati, Solid State and Electrochem. Lett, submitted

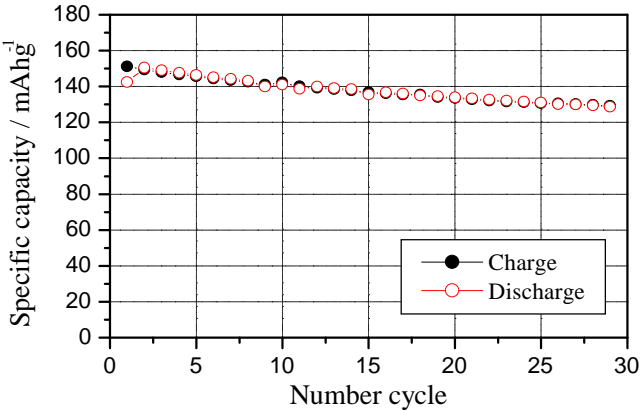


Figure 1. Cycling response of Li / P(EO)₂₀LiCF₃SO₃+ 10 w/o Al₂O₃ / Catodo LiMn₃O₆, battery at 70 °C and at C/5.

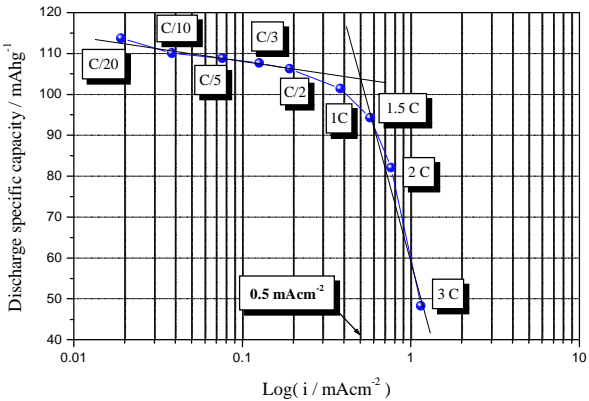


Figure 2. Polarisation curve of the Li/(PEO)₂₀ LiCF₃SO₃ +10w/w Al₂O₃/LiFePO₄ battery at 105 °C. To be noticed that the cell can operate up to a 2C rate before reaching concentration polarisation limits, this feature being associated to the enhanced value of the Li⁺ transference number of the nano-composite polymer electrolyte.